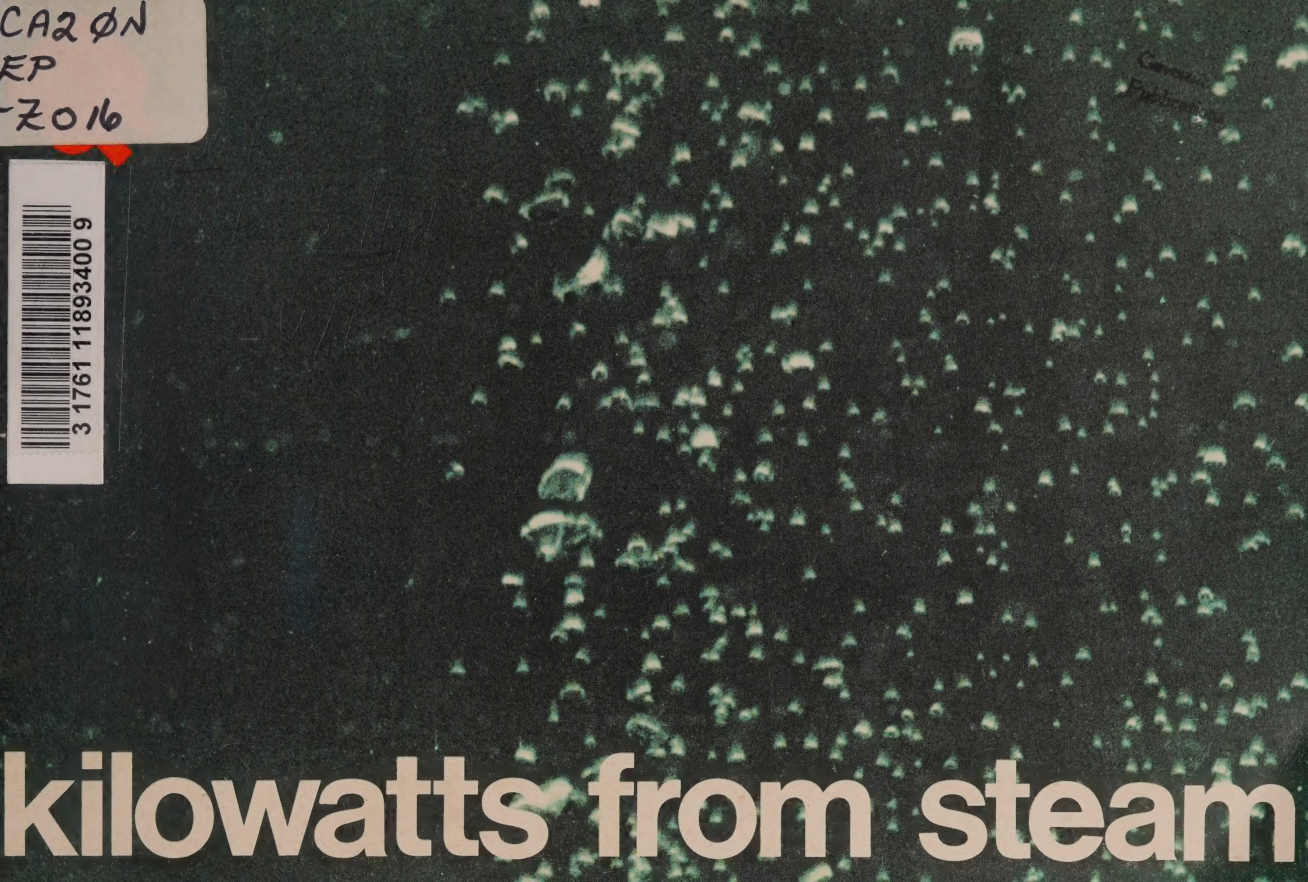
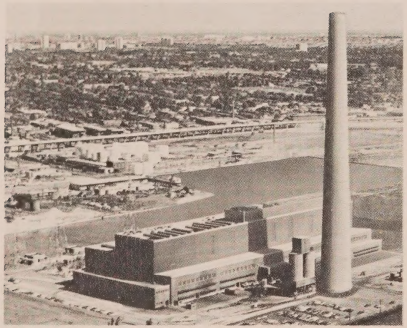


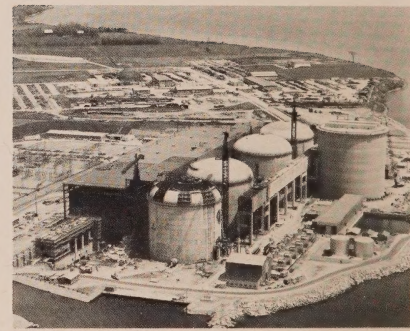
kilowatts from steam

Hydro must now use coal, oil and gas as well as natural uranium to meet power demands. Lennox station, to be built near Kingston, will be first to use oil.



Richard L. Hearn generating station, Toronto - natural gas and coal

Lakeview generating station, on western outskirts of Metro Toronto - coal



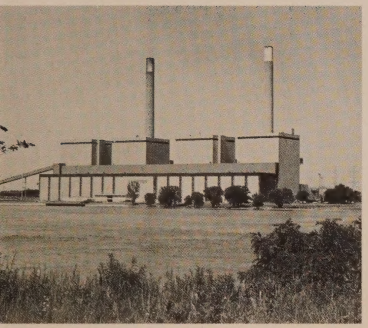
Pickering nuclear power station, near Toronto - natural uranium

[Ontario]

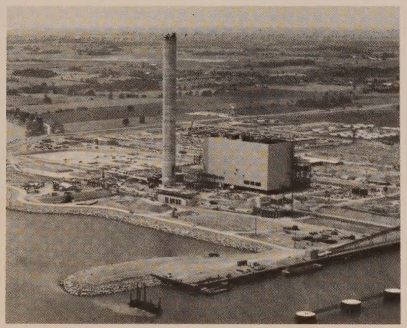
Ontario Hydro

V/F

kilowatts from steam



Lambton generating station, near Sarnia - coal



Nanticoke generating station, east of Port Dover on Lake Erie - coal

Ontario Hydro must now consider all types of fossil fuels — coal, oil and natural gas — as well as nuclear-electric power to produce the increasing amounts of electricity needed by the growing province.

Power demands are doubling every 10 to 12 years. By 1980 Hydro's capacity will probably reach 28;000,000 kilowatts — more than twice the 1970 level.

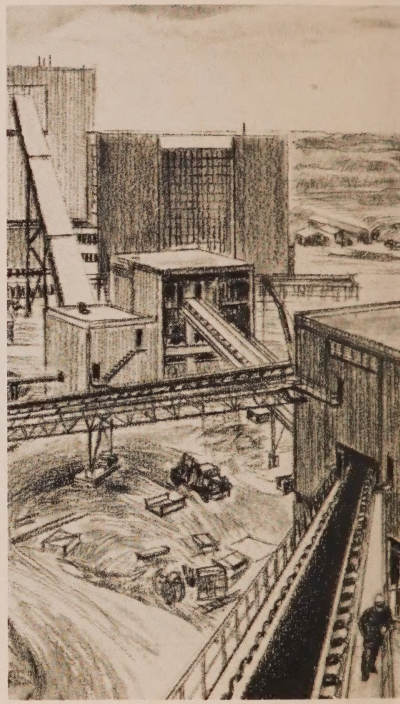
Most of the major economical sources of hydro-electric power have been developed and in recent

years the emphasis has shifted to thermal-electric generation. Ontario Hydro now produces as much power by this means as it does from all of its river plants. As a result, it has had to import larger and larger tonnages of coal, mainly from the United States. Estimates indicate Hydro will likely need up to 16,000,000 tons of coal a year by 1977.

However, coal supplies are limited, particularly low-sulphur coal to meet air quality regulations, and Hydro is exploring the use of low-sulphur oil and natural gas as alternatives. Limits on the availability of oil and gas arise, however, because of the quantities required and the distance of sources of supply. Price, too, is an important factor in operating costs.

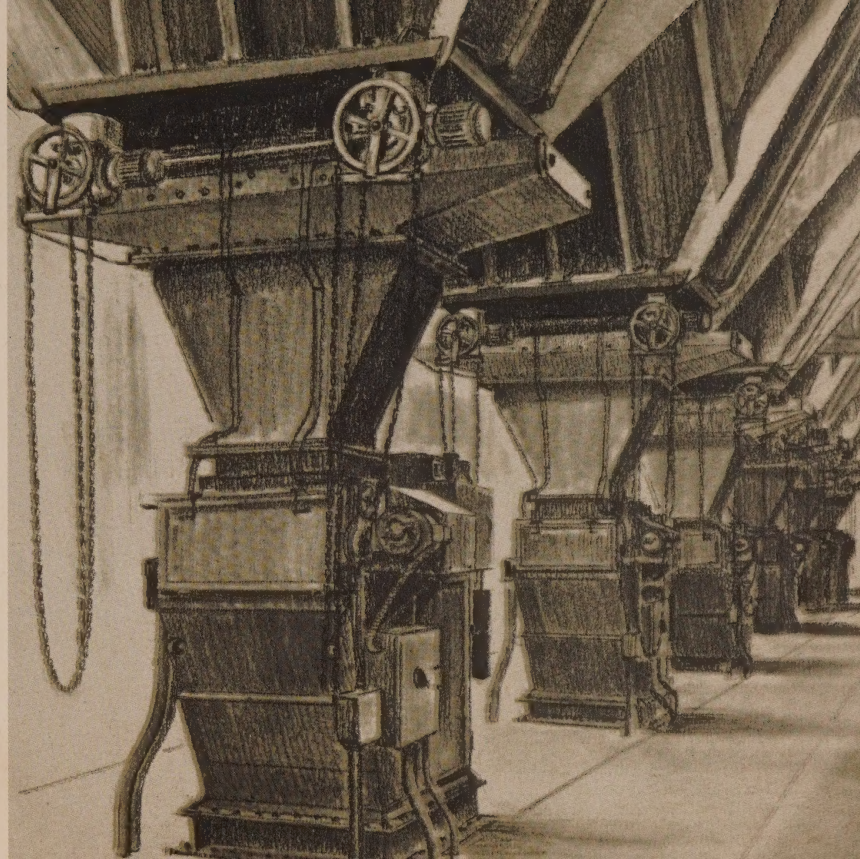
Existing pipeline facilities from Western Canada are inadequate to supply the large quantities of oil or gas needed by Hydro for its giant stations. Oil for the new Lennox Generating Station near Kingston, for example, will probably be imported from off shore.

This marks Hydro's first use of oil for a major plant. Natural gas became a part of Hydro's fuel supply picture in 1970 with the announcement that the Richard L. Hearn station in downtown Toronto would be partly converted from



Coal handling facilities are designed for efficiency and economy at Lakeview Generating Station on the western outskirts of Toronto. Self-unloading coal carriers discharge coal into hoppers at the 2,200-foot dock and causeway jutting into Lake Ontario. Two conveyors with a combined capacity of 5,000 tons an hour carry coal through a weatherproof dock tunnel to a storage pile which can accommodate 3,000,000 tons. Two inclined conveyors carry coal into the powerhouse, where it is fed into bunkers.

Coal flows from bunkers into weigh scales which measure each 500-pound load on its way to the boiler or furnace. Depending on requirements, the furnace may burn up to 103 tons of coal an hour.



coal to gas. Air quality control rather than economics prompted this change. Fuel supply at other stations is also being reviewed in the light of changing conditions.

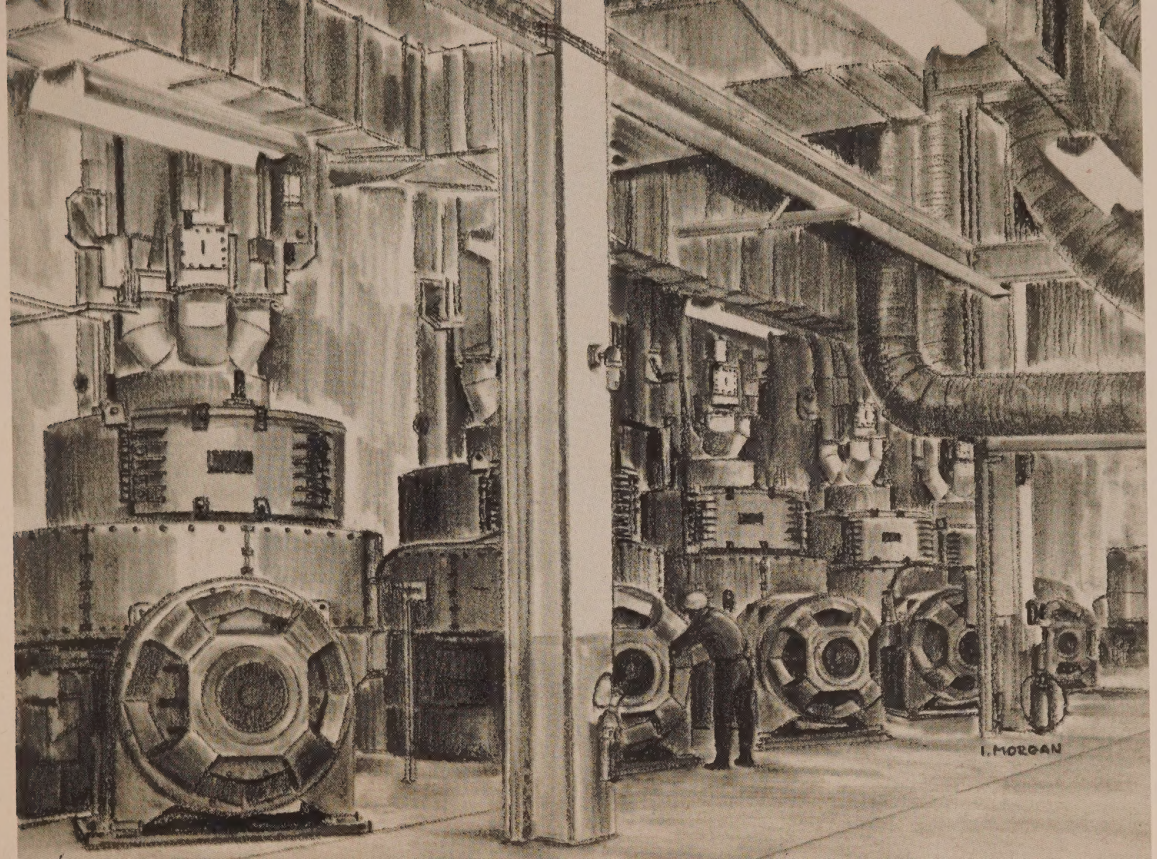
Abundant supplies of natural uranium are available in Ontario to fuel nuclear reactors now under construction and those to be built in the future. Under construction are the 2,160,000-kilowatt Pickering station near Toronto and the 3,200,000-kilowatt Bruce project at Douglas Point. But it is not feasible at this time for Hydro to go all nuclear in its building program. Canada's nuclear industry could not handle a program of this magnitude and Hydro wants more operating experience with this type of plant before proceeding further.

Therefore, Hydro must make efficient use of fuels other than uranium in its expanding operations.

The future pattern of generation will see Hydro using all three fossil fuels and uranium at various stations to meet the major portions of its demands. Hydro-electric plants will continue to supplement their output but will provide a declining share of total production.

In the long run, however, nuclear power stations are expected to play an increasingly important role in providing electricity for the province. This will lessen Hydro's dependence on foreign fuel and help conserve Canadian reserves of fossil fuels.

From the weigh scales the coal passes through pulverizers which grind it to the consistency of talcum powder. Huge fans blow a mixture of warm air and pulverized coal into furnace, where it is instantly ignited.


I. MORGAN

steam power

Each day, scores of turbines spin in Ontario Hydro's power plants, driving the generators that produce electricity for more than 2,300,000 customers. Most turbines are still propelled by falling water from the province's many rivers. But a growing number of much larger turbines are spun by the force of super-hot jets of high-pressure steam in modern thermal-electric generating stations.

By 1980 fossil-fuelled stations and nuclear plants will supply three-quarters of Ontario Hydro's power requirements.

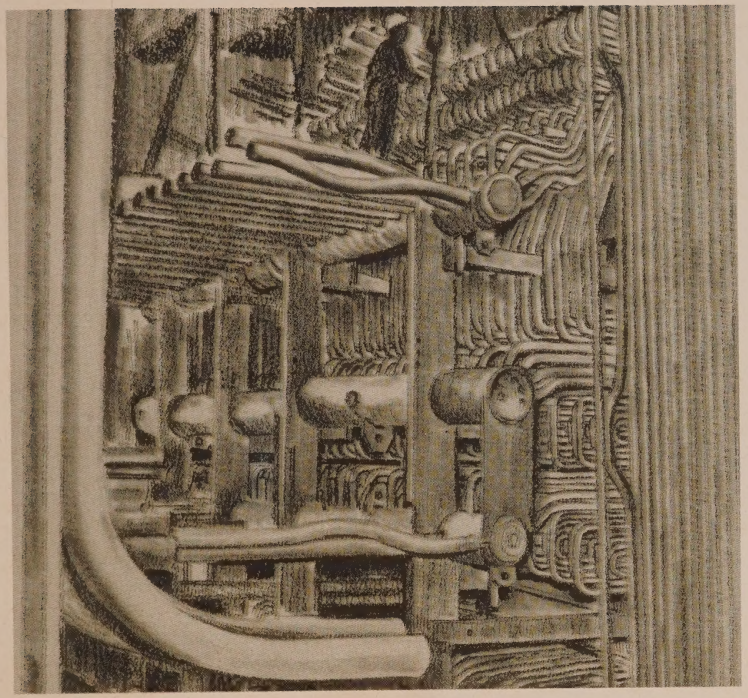
The use of more steam is necessary because Ontario Hydro has developed almost every economical hydro-electric resource in the province. This has meant bringing increasing quantities of coal into Ontario for thermal plants — and utilizing the province's abundance of natural uranium to produce electricity in nuclear power stations.

Of the three fossil fuels, coal was chosen initially because the others — oil and gas — could not compete in terms of price of availability. However, the fuel supply picture has changed in recent years. Hydro will burn oil at its Lennox Generating Station near Kingston, and increasing use of oil and gas is being investigated.

Coal-fired stations in the Ontario Hydro system have a combined capacity of nearly six million kilowatts. Vast quantities of coal are used.

For example, a 2,000,000-kilowatt thermal-electric station may burn up to 800 tons of coal an hour, enough to keep a home furnace operating for more than 100 years. Larger, more efficient turbine-generator units are being developed, and even greater stockpiles of coal will be required to feed new thermal plants unless coal is supplemented by oil and gas.

Hydro first turned to steam in 1951 when coal-fired stations in



Lakeview has eight boilers, each capable of producing 2,000,000 pounds of steam an hour. Each boiler contains 150 miles of tubing, enough to stretch from Toronto to Kingston. Sketch shows superheater section of boiler.

Windsor and Toronto were brought into service. Impetus was added in 1959 when the massive St. Lawrence power development tapped the last major hydro-electric resource in Southern Ontario.

Today, even more than a decade ago, thermal stations are essential to supplement the output of hydro-electric plants supplying the province.

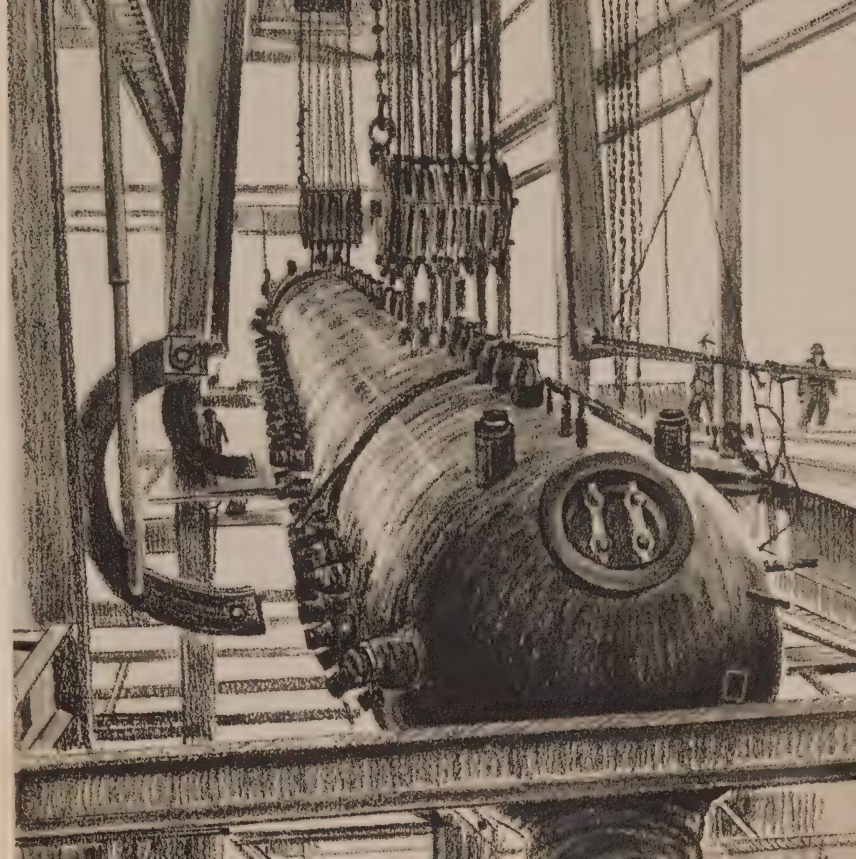
Industry and commerce use about 70 per cent of the power produced by Hydro. Urban residential customers account for about 25 per cent; by far the greatest part of this is used for home heating, lighting, water heating, cooking and laundry. Farming and food production are other important uses.

Nuclear power stations are expected to be economically competitive with fossil-fuelled plants in producing electricity. The Douglas Point plant is generating increasing amounts of electricity. Pickering station is expected to produce first power in 1971 and the Bruce nuclear station is scheduled to start operation in 1975.

Fossil-fuelled thermal-electric plants are less costly to build than hydro-electric or nuclear plants but operating costs are higher. Recent developments in technology, though, and the present high cost of borrowing money have made coal and oil-fired stations more competitive. Engineers now squeeze 2½ times more electricity from coal and oil than they could 40 years ago. Ontario Hydro has incorporated many technological advances, involving automation, high-pressure, high-temperature steam and larger units into its thermal plants to promote higher efficiency. With even larger units, greater efficiency and cost-savings are expected.

Fossil-fuelled plants offer these advantages over hydro-electric stations:

- They can be built close to areas of high electricity consumption to reduce not only transmission line

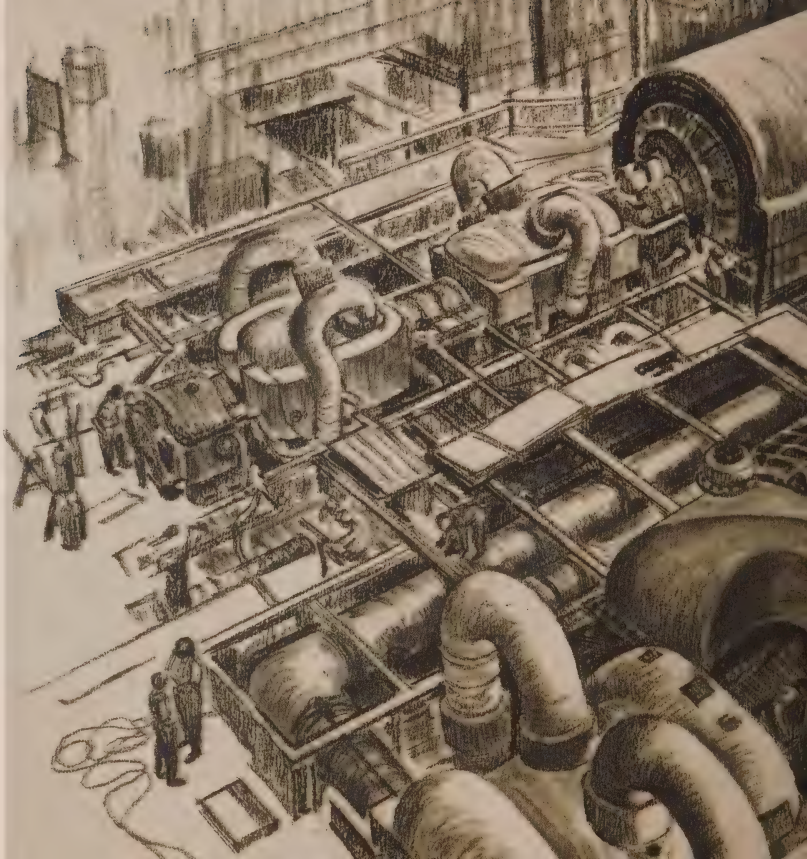


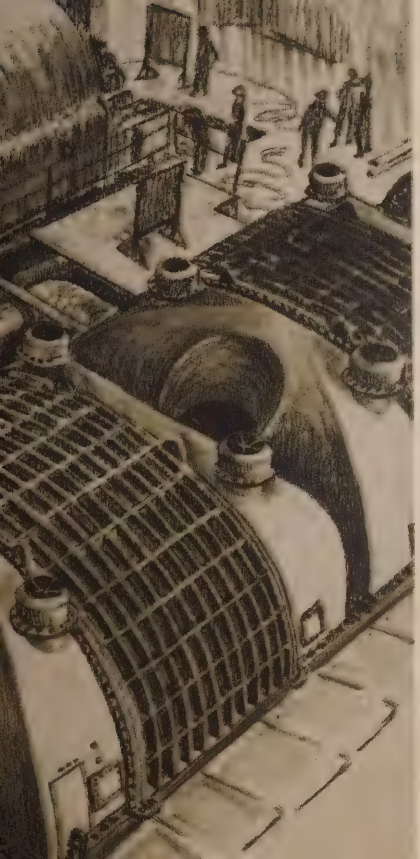
Steam generated by boiler collects in a 212-ton drum, then flows to the superheater which raises its temperature to 1,000 degrees before it is fed to the turbines. It is installed in the station at the height of an 18-storey office building.

costs but also losses of energy caused by dissipation of heat into the atmosphere.

■ They can provide additional security of service in areas otherwise dependent on long transmission lines.

■ They are flexible sources of power which, for example, can supplement generation from hydroelectric plants on rivers with widely-fluctuating flows. They can be used either to supply power continuously or as a backup source of power to meet peak demands for short periods of time or to cope with day-to-day operating contingencies.





hydro's steam plants

Ontario Hydro has 11 major fossil-fuelled and nuclear power plants operating, under construction or approved for construction. The coal-fired plants are:

- J. Clark Keith generating station at Windsor, with a capacity of 264,000 kilowatts. Its four units were placed in service between 1951 and 1953.
- Richard L. Hearn generating station, on the Toronto waterfront. The Hearn plant was enlarged to eight units following initial production in 1951. Completed in 1961, it has an installed capacity of 1.2 million kilowatts.
- Thunder Bay generating station at Thunder Bay was commissioned in 1963. Its capacity is 100,000 kilowatts, but the site is adequate for extension to 1,000,000 kilowatts.
- Lakeview generating station is situated on the western outskirts of Toronto. Lakeview has a capacity of 2.4 million kilowatts from eight units. The first was started up in 1961 and the last in 1968.

Sketch shows complex structure of generating unit during construction. Pipes carry steam from high-speed to low speed line of turbo-generators.

■ Lambton generating station, about 14 miles south of Sarnia, features the first 500,000-kilowatt units ever ordered by a Canadian utility. Four units are in service.

■ Nanticoke generating station, just east of Port Dover on Lake Erie, will have eight 500,000 kilowatt units. The first is scheduled for service in 1971 and the station is scheduled for completion in 1977.

Oil-fired

■ Lennox generating station, Hydro's first major oil-fired plant, will be constructed west of Kingston on Lake Ontario. The first of four 575,000-kilowatt units is expected to produce power in 1974.

Nuclear

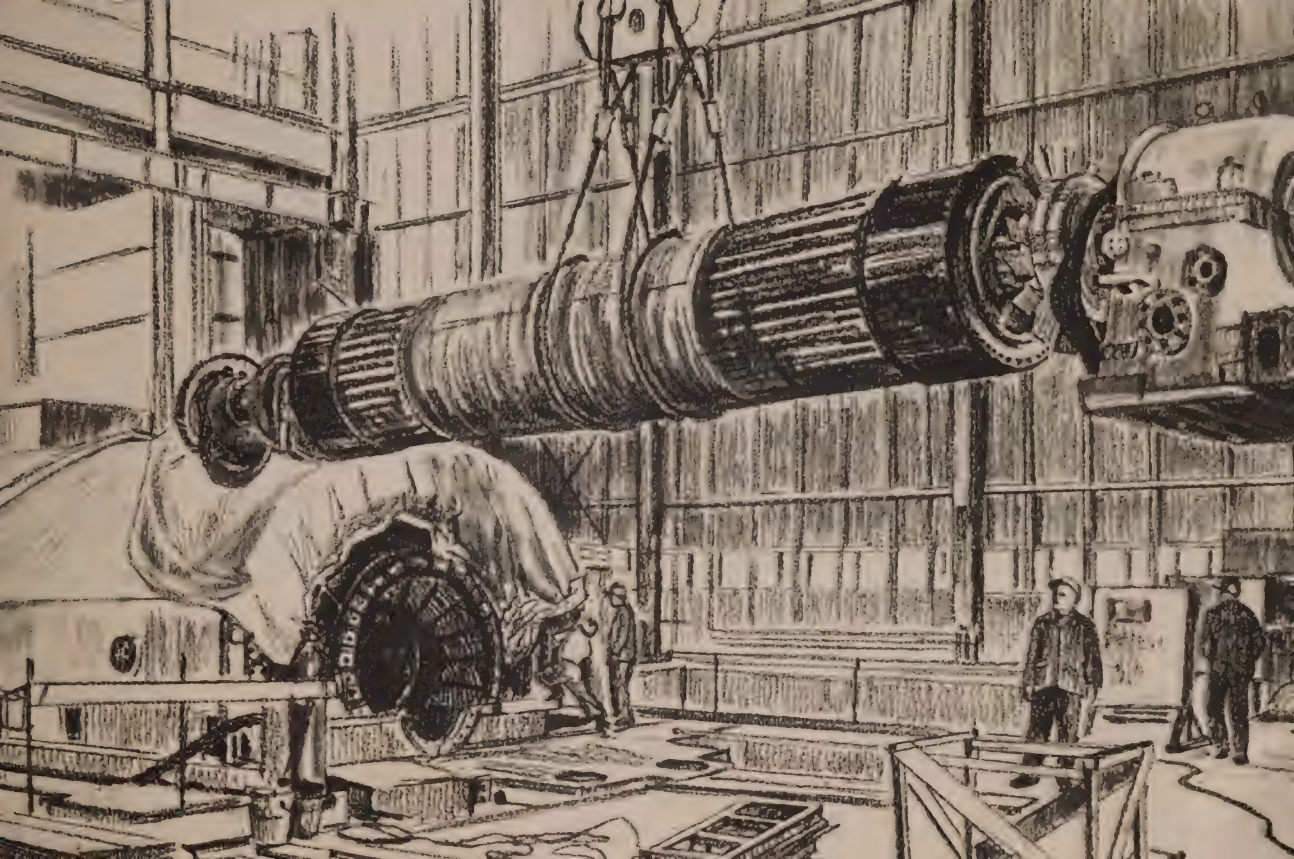
■ The 20,000-kilowatt Nuclear Power Demonstration (NPD) plant, located at Rolphton on the Ottawa River, has been producing power since 1962.

■ The 200,000-kilowatt Douglas Point nuclear power station, on Lake Huron between Port Elgin and Kincardine, first produced power in 1967.

■ Pickering generating station, 20 miles east of downtown Toronto, is scheduled to produce first power in 1971 from the first of four 540,000-kilowatt units.

■ Bruce generating station, adjacent to the Douglas Point plant, is scheduled to produce first power in 1975 from the first of four 800,000-kilowatt units.

A 50-ton rotor is being manoeuvred into position for insertion into core of generator. The generators are cooled by hydrogen gas.



lakeview in operation

Lakeview generating station is an example of modern steam technology, achieving a high degree of efficiency and incorporating the latest and most effective pollution controls.

How does it operate? The story begins with the arrival of coal at the station site by ship. Two self-unloading 28,000-ton coal ships at a time can tie up at the 2,200-foot dock and causeway that thrusts out into Lake Ontario. Out of the holds, the coal goes to conveyor belts which can feed 5,000 tons an hour through a weatherproof, dust-controlling tunnel to the coal-pile. There large tractor-scrapers spread, level and compact the coal in an area big enough to hold 3,000,000 tons.

A second conveyor system channels the coal into the powerhouse. Then the coal is pulverized to the texture of talcum powder and air fans blow the black powder into the furnaces of the steam generators.

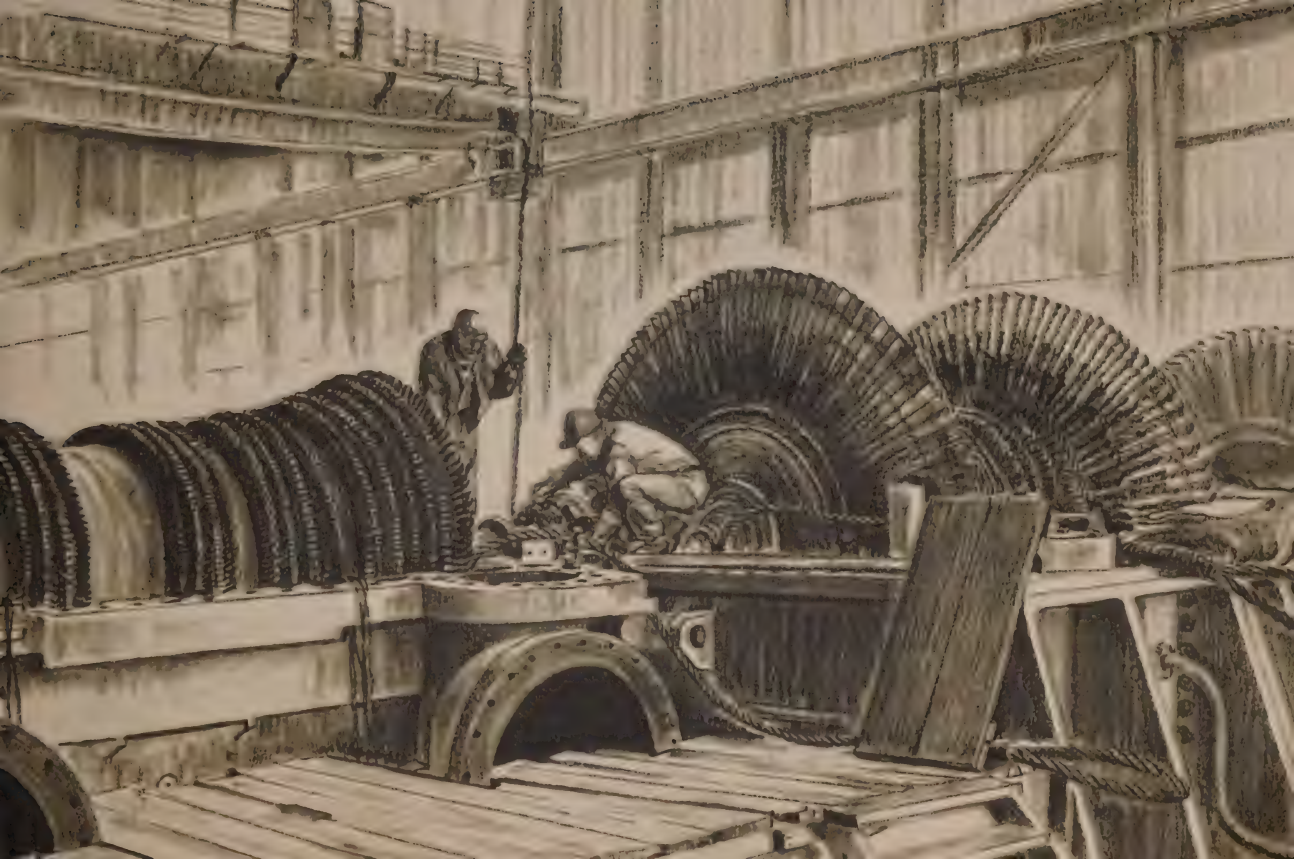
(In oil-fired stations, the fuel is pumped from storage tanks and sprayed into the furnace.)

Steam superheated to 1,000 degrees Fahrenheit is the force that drives the 300,000-kilowatt turbine-generators, the largest in Canada until Lambton's 500,000-kilowatt units. Each Lakeview boiler can produce 2,000,000 pounds of steam an hour. It hits the turbine blades at a pressure of 2,350 pounds per square inch.

The turbine-generators

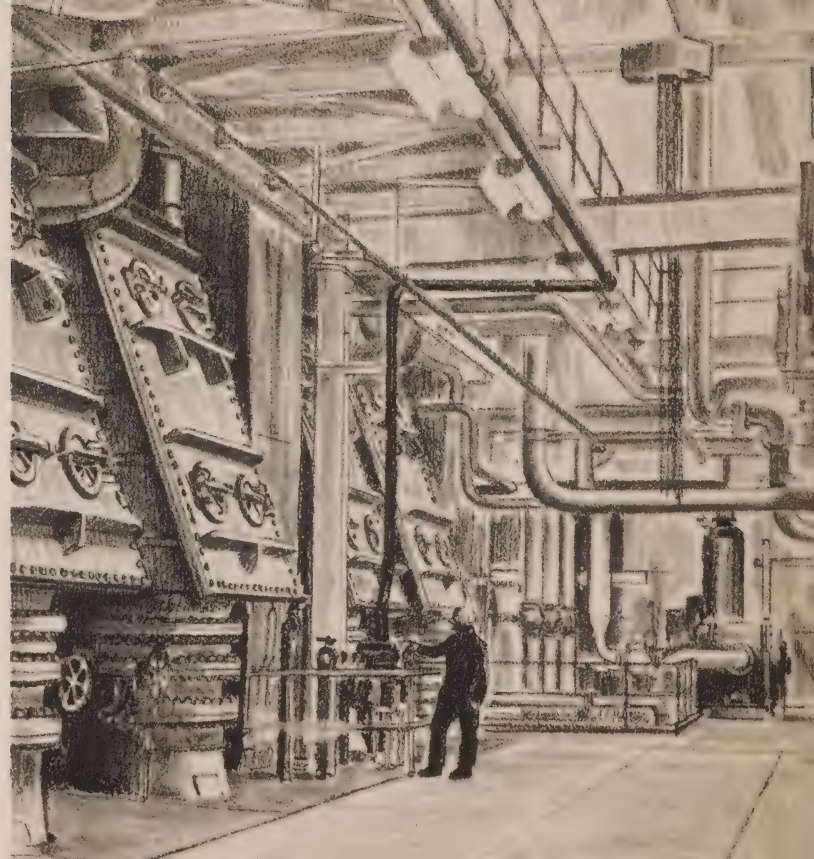
Blades ranging from just over two inches to 34 inches long are arrayed to catch the full force of the steam, travelling at ten times the velocity of a tornado. Blade

Workmen install turbine rotor, which is coupled to the generator. Blades ranging from 2 to 34 inches in length are designed to use full force of steam which enters turbine at 1,000 degrees and 2,350 pounds pressure per square inch, equal to the pressure 5,500 feet under the sea.



tips spin at speeds up to 1,100 miles an hour — faster than the speed of sound.

The first two units at Lakeview have two turbine shafts parallel to each other; the others have a single shaft. Either way, the idea is to use the steam at least twice to spin the turbine shaft that drives the generator, and the steam is reheated to 1,000 degrees between cycles.



Steam discharges from turbines to condensers, each containing 100 miles of tubing through which 170,000 gallons are pumped every minute. At full operation plant will use 1,000,000 gallons of cooling water a minute. Water is returned to the lake in pure condition.

This is no slow, drawn-out process. Within seconds, particles of coal and steam generate 16,000 and 18,000-volt pulses of electricity.

Three-hundred-ton transformers, as high as a two-storey house, step up the power to 230,000 volts so it can be sent over the provincial power grid. It is stepped down again several times to supply a home.

protecting the environment

By their very nature, fossil-fuelled stations contribute to air pollution. So do factories, backyard barbeques, fireplaces, home furnaces and automobiles. In fact, in Metro Toronto, experts agree that internal-combustion vehicles alone account for about 55 per cent of the air pollution. Industrial processes and residential heating units which use fossil fuels are other major sources.

But while the presence of contaminants in the air seems an inescapable fact of modern life, Ontario Hydro takes elaborate precautions to avert and minimize its contribution to air and water pollution.

At its stations, Hydro has consistently played a leading role in control and prevention. Behind this guide-line are the intensive efforts of meteorologists, engineers, chemists, skilled operations personnel, architects and physicians on Hydro's staff.

The Commission has spent or committed more than $56,000,000 on air quality control measures at its coal-fired stations and at the oil-fired Lennox plant. As more efficient equipment has become available, existing equipment has been updated.

Hydro has pledged to install even better equipment when it is

developed for practical application in large thermal plants.

Cleaning flue gases

Fly ash and sulphur dioxide gas are Hydro's two main enemies in its efforts to preserve air quality. Coal and oil contain various quantities of sulphur and ash which are controlled by rigid Hydro fuel specifications.

Electrostatic precipitators, designed for 99.5 per cent efficiency, remove fly ash from the flue gases before they enter the chimneys. The tiny dust particles cling to electrically-charged plates until they are jarred by rapping devices and fall into hoppers for disposal.

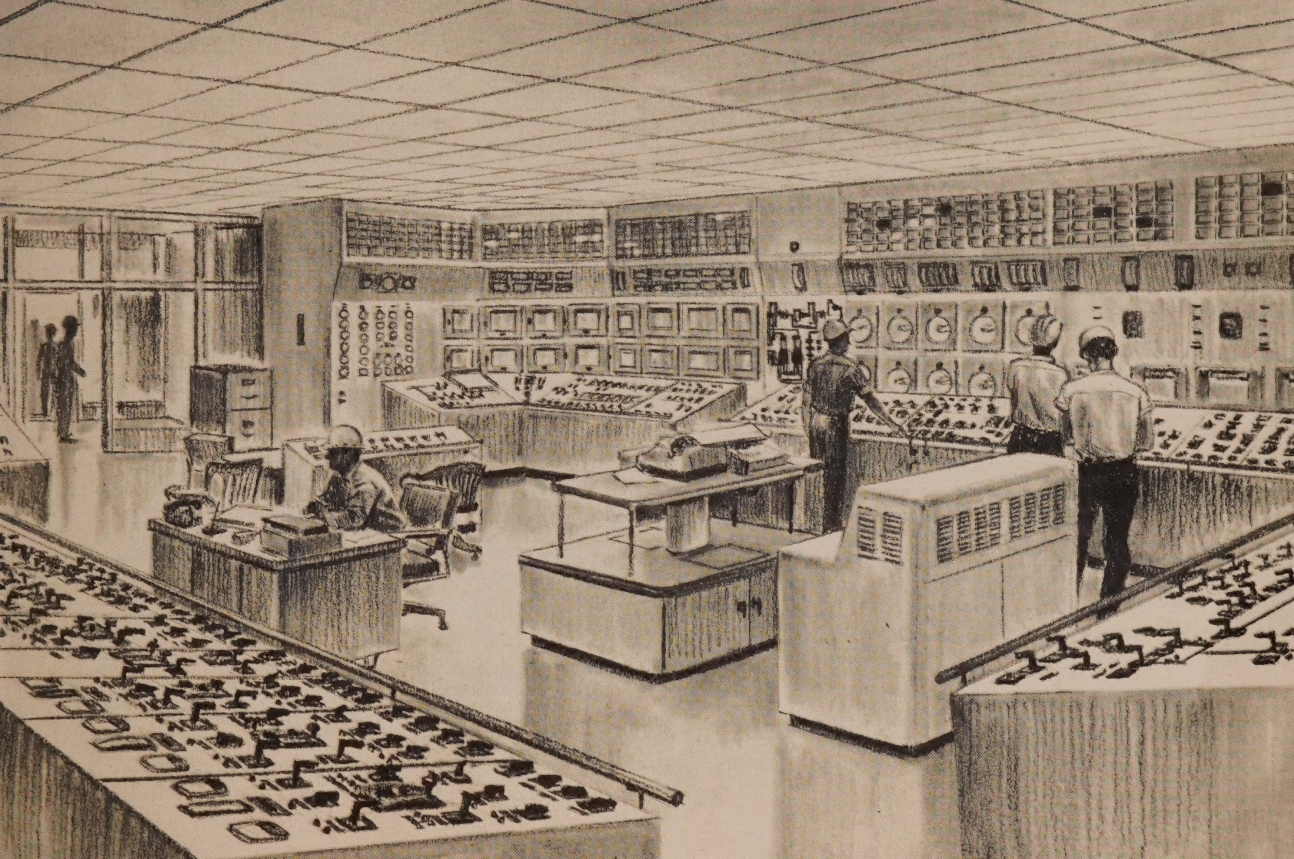
Removal of sulphur dioxide from flue gases is a much more difficult problem. A practical method of removing highly diluted quantities of sulphur dioxide from large volumes of flue gases in large power stations has not yet been developed despite intensive research in many countries.

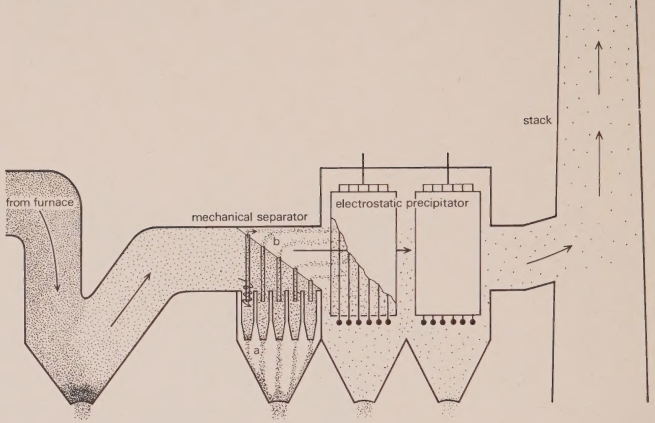
Hydro researchers are exploring three possible methods of removing sulphur dioxide. These involve reactions with a solid, a liquid or another gas. A pilot plant has been installed at the R.L. Hearn generating station on the Toronto waterfront to test a scrubbing device in which limestone absorbs sulphur dioxide.

Hydro is also participating with other utilities in a U.S. research project to explore another method of cleansing flue gases.

Air pollution problems are increased by a natural atmospheric condition called a temperature inversion. Hydro's tall chimneys are designed

Array of gauges, meters, levers, and lights in control room indicates high degree of automation in Lakeview station.





to pierce inversions and prevent ground level concentrations which might be harmful to people or vegetation.

Meteorologists and design engineers make detailed studies of the frequency and height of inversions in the locale of proposed fossil-fuelled stations. This is why Lakeview's chimneys are more than 490 feet tall, Lambton's are 550 feet and Nanticoke's are 650 feet. The new 700-foot Hearn stack is designed to produce a marked improvement in air quality in the Toronto area.

Experts take into account wind speed and direction; existing pollution levels, and any other factors that help Hydro keep pollution to a low level.

In addition, Hydro stockpiles quantities of low-sulphur coal (less than 1% sulphur) for burning during adverse weather conditions. When Hydro meteorologists forecast such conditions, stations switch to low-sulphur coal or cut back production to meet air quality regulations.

All fossil fuels (including natural gas) give off nitrogen oxides when they are burned in homes, factories, vehicles or power plants. During combustion, nitrogen in the air combines with oxygen to form the gas which is a component in photochemical smog.

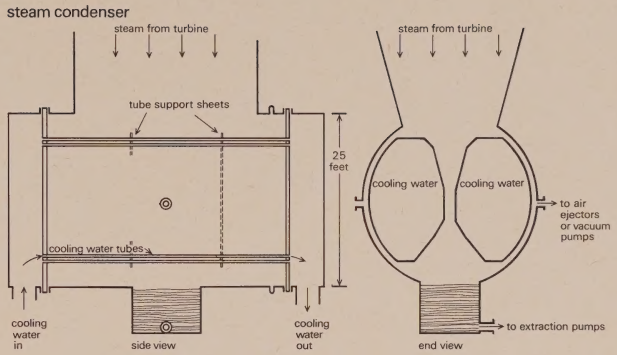
The oil-fired Lennox station will use a low excess air firing technique which reduces nitrogen oxides by limiting air supply to the boiler. Other control methods are being investigated by Hydro and other utility systems.

Water

This simplified diagram shows how water is used in thermal plants.

Great quantities of lake water are used by Hydro's thermal plants for cooling purposes — converting low grade steam into water in the condensers. This cooling water is returned to the lakes warmer but in no way contaminated by its passage through the plant.

The water has no measurable effect on the overall temperature of the lakes. Hydro is conducting studies in co-operation with the Department of Lands and Forests, the Ontario Water Resources

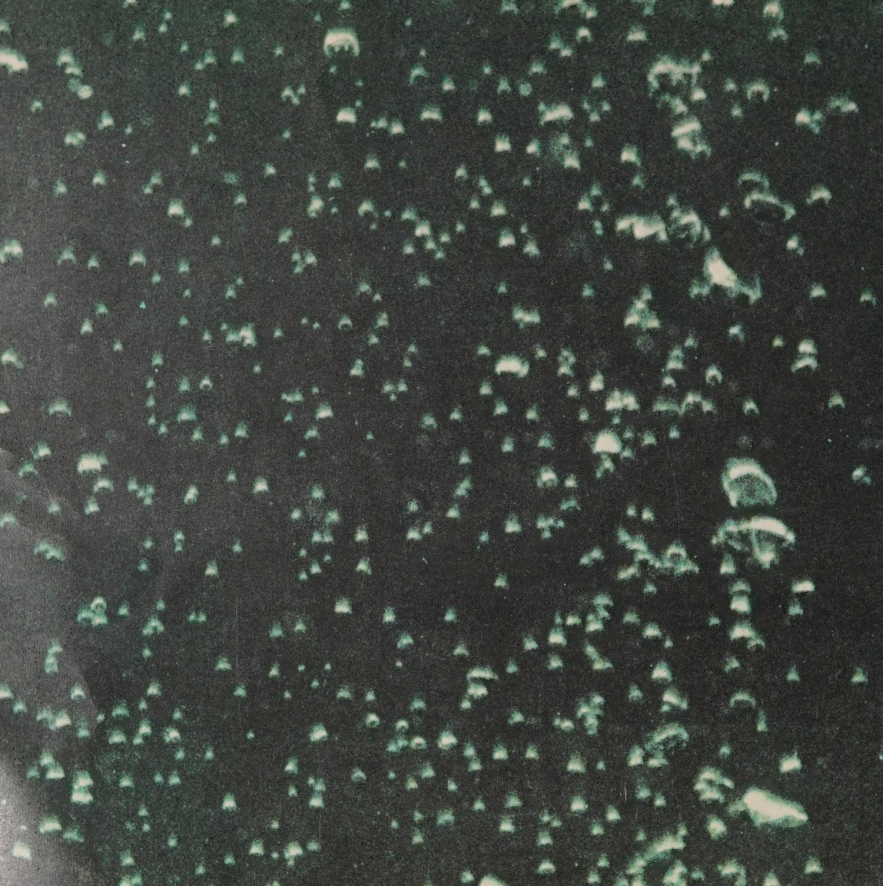


Commission and other agencies to assess localized effects on fish and weed growth. In some areas warm water has proved beneficial for fish farming.

There is no contact between the cooling water and water used to produce the superheated steam needed to drive the turbine generators. Water employed in the steam cycle is used over and over again and needs only minor replenishment. Cooling water is used only once in a straight-through process.

Water used in the production of steam is demineralized and carefully kept "clean" to prevent the accumulation of boiler scale and cut corrosion, thereby prolonging the life of the boilers and other equipment.

Similarly, screens on cooling water intakes strain out the debris which might tend to clog pipes and hamper efficient operation.



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